Dear Professor Cate Macinnis-Ng, Associate Editors, and Reviewers,

We greatly appreciate your valuable comments and have carefully addressed each one below. Here is an overall summary of our revisions based on your feedback:

1) Strengthened the background information on how year, farm type, and crop stage may affect the diet composition of generalist arthropod predators via changes in predator/prey abundance, and better linked it to the research questions in this study.

2) Clarified the sample sizes in the analyses and revised the replication statement.

3) Added an analysis on the effects of year, farm type, crop stage, and percent forest cover on predator and rice herbivore abundance in the field.

4) Ran an additional stable isotope mixing model with predators included as an extra prey source to address the potential issue of intraguild predation.

5) Performed a sensitivity analysis of the trophic discrimination factors (TDFs) using the published TDFs for the studied taxa.

6) Expanded our discussion of intraguild predation in a stand-alone paragraph in the study limitations.

Please note that new analyses do not change the conclusions of this study. We believe that the revisions based on the review comments have greatly improved the quality of this manuscript, and we hope that the manuscript is now suitable for publication in *Journal of Applied Ecology*.

Thank you for your time and consideration.

The following are our responses to the comments, organized into five sections:
- Editor's comments
- Associate Editor's comments
- Reviewer 1's comments
- Reviewer 2's comments
- Reviewer 3's comments

Please note that the comments are highlighted in gray, followed by our responses.

Editor's comments

Thank you for submitting your manuscript to Journal of Applied Ecology. I have now received the reviewers' reports and a recommendation from the Associate Editor who handled the review process. Copies of their reports are included below. This manuscript has the potential to make a valuable contribution to the area although there are a number of significant concerns which need to be addressed. I have considered your paper in light of the comments received and I would like to invite you to prepare a major revision.

In addition to addressing the comments from the reviewers, I also have some a comments of my own that should be addressed. The journal scope is specifically focussed on management of natural systems. I can see your paper is highly relevant to this but it could be more clearly stated in the discussion (and possibly the abstract). Please take some time to re-craft your discussion to cover this (beyond pest and agricultural management). You may find our recent editorial helpful for your thinking on this https://besjournals.onlinelibrary.wiley.com/doi/full/10.1111/1365-2664.14653

[Reply]

1) We appreciate the Editor's positive and constructive comments. In the Discussion section, we now cite Rader et al. (2024) from the *Journal of Applied Ecology* to touch on the issue of biodiversity and food production:

   "In response to the growing global demand for environmentally friendly agricultural practices that support both biodiversity and food production (Rader et al. 2024), we investigated the potential of GAPs (ubiquitous in nature) as biocontrol agents in rice agro-ecosystems."

2) Our discussion also addresses the effect of agricultural habitat complexity on predator diversity:

   "Complex habitat structure (e.g., surrounding vegetation) has been suggested to promote predator abundance and diversity (Diehl et al. 2013; Langellotto & Denno 2004), but such higher complexity did not affect predators' diet composition in our study…"

3) Furthermore, our discussion provides a suggestion on how to maintain predator biodiversity and the associated ecosystem services:

   "These findings indicate a higher biocontrol value of predators when the crop production is most vulnerable to pest damage. Therefore, farming practitioners may want to avoid

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practices that harm predators (e.g., chemical applications) during this period to maintain healthy predator populations, preserve predator biodiversity, and sustain the ecosystem services they provide."

4) After including our responses to reviewers' comments, our article is nearing the word limit of *Journal of Applied Ecology*. Therefore, we may not be able to expand the discussion on the issues raised by Rader et al. (2024).

Associate Editor's comments

Following the evaluation of the manuscript titled "Generalist predators function as pest specialists: examining diet composition of spiders and ladybeetles across rice crop stages" by the three reviewers, we have concluded that a major revision is necessary before we can consider the publication of this study.

The first reviewer acknowledged the interesting narrative regarding the diet composition shift of generalist arthropod predators over the rice growth period and their potential utility in biocontrol. However, several concerns were raised, including insufficient sample size, which compromises the robustness of the conclusions, and the similarity in methodology and results with a previously published study, raising questions about the originality of the work. The reviewer also suggested minor clarifications and details needed in various sections of the text.

The second reviewer appreciated the impressive dataset collected and the relevance of the research to the natural pest control literature but pointed out a lack of ecological theory and deficiencies in the data analyses that affect the interpretation of the results. Additionally, there were critiques regarding the clarity of the figures and tables presented.

The third reviewer praised the clarity and conciseness of the writing and the relevance of the topic. However, significant issues were noted in the study design and statistical methodologies. Specifically, the reviewer highlighted the absence of non-herbivore resources in the Bayesian mixing model analysis, which can affect the accuracy of results due to intraguild predation and cannibalism, especially in spiders. Moreover, the methodology used for calculating trophic discrimination factors (TDFs) is contested in the literature and needs to be reviewed.

Given the collective feedback, it is evident that while the study has substantial merits and contributes to understanding the role of generalist predators in biological control, significant revisions are necessary to address the raised concerns. I strongly recommend that the authors:

- Reassess and, if possible, increase the sample size per site to strengthen the conclusions. Include other potential non-herbivore prey in the Bayesian mixing model analysis, considering the complex diet of predators like spiders.
- Review the methodology for calculating TDFs, considering existing criticisms, and, if necessary, use pre-established TDF values for the studied taxa from the literature.
- Address the issue of intraguild predation and its implications for biological control more thoroughly in the discussion.
- Respond to specific minor critiques from the reviewers regarding clarity and detail in the manuscript.

[Reply] We thank associate editor's constructive comments and briefly summarize our responses below. Details are provided in our point-by-point responses to reviewers' comments.

1) *"Reassess and, if possible, increase the sample size per site to strengthen the conclusions."*

   This comment is based on Reviewer 1's feedback regarding predator sample size. While we appreciate the importance of larger sample sizes, there may be a misunderstanding regarding the relationship between predator individuals and our samples size (i.e., stable isotope capsules). In short, the number of predator individuals analyzed in this study may be more representative than what the reviewer assumed.

   Please allow us to explain this. After collecting a large number of specimens, we analyzed 352 predator isotope capsule samples and 828 prey isotope capsule samples, constrained by budget limitations. The predator samples including 252 spider capsules and 100 ladybeetle capsules, resulting in an average of 252/86 = 2.9 predator capsules (data points) per site × stage × year in our model for "Spiders", 100/57 = 1.8 predator capsules for "Ladybeetles", and 352/94 = 3.7 predator capsules for "Both predators".

   Please note that each predator isotope capsule may contain one or multiple predator individuals (depending on their dry weight), so the actual number of predator individuals involved in the stable isotope analysis was higher than the number of capsules. This makes our data more representative, as each capsule may reflect an average result for the predators. Moreover, the MCMCs in our Bayesian stable isotope mixing models all converged, indicating that the data inputs were adequate and the model results were reliable. Therefore, we feel that our interpretation of the results and the conclusions drawn remain valid.

   As suggested by Reviewer 1, we have added the number of stable isotope capsules for the predators and prey sources to Table S1.

2) *"Include other potential non-herbivore prey in the Bayesian mixing model analysis, considering the complex diet of predators like spiders."*

   Our original Bayesian mixing model analysis did include a non-herbivore prey source "detritivores", which were abundant in the early rice growth season and provided an important food resource for predators.

   We have also performed an additional mixing model analysis with predators included as an additional prey source following Reviewer 3's suggestion. The results show that predators constituted a negligible portion of the predators' diet (< 10% overall), suggesting low levels of intraguild predation in our study system. Moreover, the proportion of rice herbivores in predators' diet remained almost unchanged in the new analysis. Given the similarity of

results and the following technical/ecological reasons (a-e), we have decided to retain our original analyses while addressing intraguild predation in greater depth in the section of study limitations.

Technical/ecological reasons:
(a) For stable isotope mixing model analysis to produce reliable estimates, the number of prey sources should not exceed the number of isotopes + 1 (e.g., 2+1=3 for this study). Therefore, our original analysis using three prey sources is more appropriate. Although Bayesian stable isotope mixing models can accommodate more sources, adding predators as a fourth prey source with only two isotopes could increase model complexity and introduce greater uncertainty in the estimates of other prey sources.

(b) As suggested by Reviewer 3, we tested an alternative approach by including only those predator individuals whose isotope signatures fell within the prey mixing polygon as a "prey" source. The new results are consistent with our original analysis (please see figures below).

[Our original analysis]
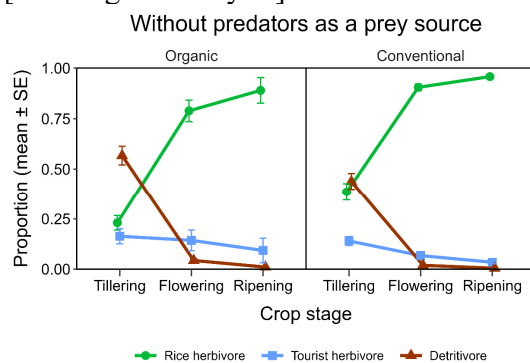
[Including predators as a prey source]
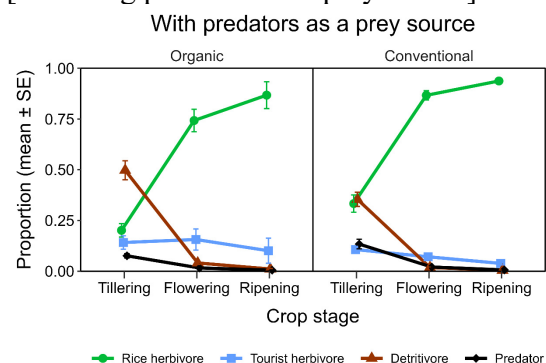
(c) The abundance of non-predator prey sources (e.g., rice herbivores, tourist herbivores, and detritivores) was substantially higher than that of predators throughout the crop season. Please see the table below for the average numbers of prey and predator individuals / each farm in our field samples. High prey availability is known to significantly reduce intraguild predation (Lucas et al. 1998), consistent with our test results that predators did not constitute an important prey source in predators' diet.

Crop stage	Organic farm		Conventional farm	
	Predator (mean ± SE)	Prey (mean ± SE)	Predator (mean ± SE)	Prey (mean ± SE)
Tillering	14.7 ± 2.5	181.5 ± 38.6	20.7 ± 4.5	146.4 ± 29.9
Flowering	6.4 ± 1.3	81.3 ± 20.3	6.4 ± 2.0	110.5 ± 25.9
Ripening	20.5 ± 7.9	60.1 ± 17.1	7.8 ± 2.3	128.7 ± 62.6

(d) Structure complexity can substantially reduce intraguild predation (Finke and Denno 2006). Since rice plants develop a high density of stems at late crop stages (Fig. 1b), their high structure complexity likely reduces intraguild predation in our study system.

(e) The main spider groups in our study were web-building sit-and-wait predators, which have been shown to engage less in intraguild predation (Denno et al. 2004).

References:
Denno, R. F., Mitter, M. S., Langellotto, G. A., Gratton, C., & Finke, D. L. (2004). Interactions between a hunting spider and a web-builder: consequences of intraguild predation and cannibalism for prey suppression. *Ecological entomology*, *29*(5), 566-577.

Finke, D. L. & Denno, R. F. (2006). Spatial refuge from intraguild predation: implications for prey suppression and trophic cascades. *Oecologia, 149*, 265-275.

Lucas, É., Coderre, D., & Brodeur, J. (1998). Intraguild predation among aphid predators: characterization and influence of extraguild prey density. *Ecology*, *79*(3), 1084-1092.

3) *"Review the methodology for calculating TDFs, considering existing criticisms, and, if necessary, use pre-established TDF values for the studied taxa from the literature."*

We thank the editor and reviewer for this suggestion. As suggested, we searched the literature for TDFs relevant to our predator taxa. Our search identified one TDF study on Lycosid spiders (the closest related taxon to our species) (Oelbermann and Sechu 2002) and a TDF synthesis study on terrestrial consumers feeding on invertebrates (McCutchan et al. 2003). We performed a sensitivity analysis by running our stable isotope mixing model with these published TDFs. The model results were generally consistent with our original ones (top vs. bottom figures on the right), indicating the robustness of our findings to variations in TDF values. Please see more details in our response to Reviewer 3's comment 10.
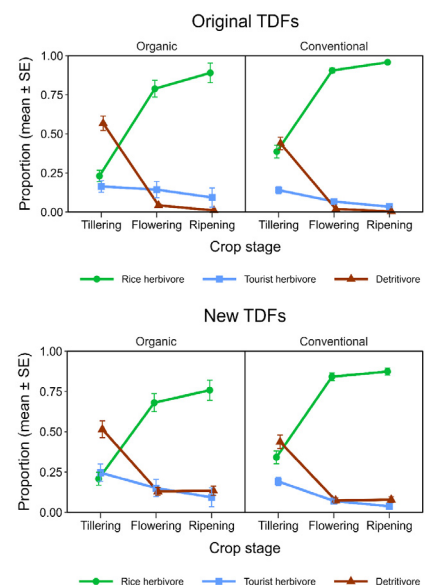
Despite this analysis, we decided to retain the original TDFs from Cault et al. (2009) in the main text for the following reasons. However, we acknowledge the potential limitations of TDF selection and provide the results using alternative TDFs in the Discussion (*4.4. Potential caveats of this study*) and Appendix C:
(a) Lycosid spiders, which are active-pursuit predators, likely have higher metabolic rates than our studied spider taxa, which are primarily web-building sit-and-wait predators. Since metabolic rates can strongly influence isotope assimilation and enrichment (Martínez del Rio et al. 2009), the TDFs for Lycosid spiders may not accurately reflect those of our predators.

(b) The Lycosid spiders in Oelbermann and Sechu (2002) consumed aphids, *Drosophila*, and collembolans, different from the primarily prey items in our study (e.g., *Nephotettix* and *Nilaparvata*; Table S1). Since prey species influence predators' stable isotope signature, using the TDFs from Oelbermann and Sechu (2002) may introduce bias into our mixing models.

(c) TDFs can be influenced by experimental conditions, such as temperature, dietary nutritional content, and predator starvation status (McCutchan et al. 2003; Vanderklift and Ponsard 2003). Since the experimental conditions in Oelbermann and Sechu (2002) likely differ from our field conditions, we suggest that the average TDFs from the synthesis by Caut et al. (2009) provide a more appropriate baseline. This approach is commonly used in studies on generalist predators (e.g., Recalde et al. 2020, Nash et al. 2023, Otieno et al. 2023).

References:

Caut, S., Angulo, E., & Courchamp, F. (2009). Variation in discrimination factors (Δ^{15}N and Δ^{13}C): the effect of diet isotopic values and applications for diet reconstruction. *Journal of Applied Ecology*, *46*(2), 443-453.

Martínez del Rio, C., Wolf, N., Carleton, S. A., & Gannes, L. Z. (2009). Isotopic ecology ten years after a call for more laboratory experiments. *Biological Reviews*, *84*(1), 91-111.

McCutchan Jr, J. H., Lewis Jr, W. M., Kendall, C., & McGrath, C. C. (2003). Variation in trophic shift for stable isotope ratios of carbon, nitrogen, and sulfur. *Oikos*, *102*(2), 378-390.

Nash, L. N., Kratina, P., Recalde, F. C., Jones, J. I., Izzo, T., & Romero, G. Q. (2023). Tropical and temperate differences in the trophic structure and aquatic prey use of riparian predators. *Ecology Letters*, *26*(12), 2122-2134.

Oelbermann, K., & Scheu, S. (2002). Stable isotope enrichment (δ^{15}N and δ^{13}C) in a generalist predator (*Pardosa lugubris*, Araneae: Lycosidae): effects of prey quality. *Oecologia*, *130*, 337-344.

Otieno, N. E., Butler, M., & Pryke, J. S. (2023). Fallow fields and hedgerows mediate enhanced arthropod predation and reduced herbivory on small scale intercropped maize farms–δ^{13}C and δ^{15}N stable isotope evidence. *Agriculture, Ecosystems & Environment*, *349*, 108448.

Recalde, F. C., Breviglieri, C. P., & Romero, G. Q. (2020). Allochthonous aquatic subsidies alleviate predation pressure in terrestrial ecosystems. *Ecology*, *101*(8), e03074.

Vanderklift, M. A., & Ponsard, S. (2003). Sources of variation in consumer-diet δ^{15}N enrichment: a meta-analysis. *Oecologia*, *136*, 169-182.

4) *"Address the issue of intraguild predation and its implications for biological control more thoroughly in the discussion."*

As suggested, we have added a paragraph to address intraguild predation and its implication in the Discussion section (please see *4.4. Potential caveats of this study*).

5) *"Respond to specific minor critiques from the reviewers regarding clarity and detail in the manuscript."*

We appreciate the time and effort from the editor and reviewers and have provided our point-by-point responses to each comment in the following section.

Reviewer 1's comments

1. The study titled "Generalist predators function as pest specialists: examining diet composition of spiders and ladybeetles across rice crop stages" shows an interesting story of how the diet composition of generalist arthropod predators switches more and more to rice herbivores during the rice growth period, suggesting their usefulness in biocontrol during the most critical crop stages when the densities of rice herbivores are high. The study also investigated the effect of different abiotic and biotic factors that could affect the diet composition, suggesting that predators in conventional farms prey more on rice herbivores and that the predation trend through crop stages is constant through the years. This suggests that spiders and ladybugs are consistent in their predation behavior inside rice fields, which could lead to the development of stable biocontrol practices.

The manuscript is well-written, with a well-elaborated and interesting introduction. The Discussion could focus slightly more on comparing the results of their study with those of different studies, but otherwise, they explained what needed to be explained. I added minor comments on several sentences that I believe should be addressed and clarified.

[Reply] We thank Reviewer 1 for the positive feedback and constructive comments. We have addressed each comment below and revised the manuscript accordingly.

2. Sample size. If I understood correctly, based on Table S2, you had 240 replicates of sites over all crop stages and years (I summed up the Ns in Table S2). And you stated that you processed 352 predators for the analysis. This means that per each site, you had, on average, 1.46 specimens. I guess that the number is larger than 1 because for some samples in the site, you added two individuals because one was not enough in mass, but this means that you had only one specimen per site for the analysis, which also explains why in some charts, especially those for ladybugs, I do not see any error bars for the relative proportion of prey sources in the diet. With that said, we are assuming the diet composition here is based on just one or a few individuals and that they represent the whole site. Even if the data is consistent through 3 years, there is still insufficient evidence to support the conclusions. The sample size should be much higher per site to draw such conclusions. If the sample size is larger and I misunderstood the methodology section, please write in Table S1 the number of individuals of each predator you investigated.

[Reply] Please allow us to clarify the sample size issue below:

1) While we agree with the reviewer that larger sample size would be ideal, our average sample size is higher than the value estimated by the reviewer. We constructed stable isotope mixing models separately for a) both predators combined, b) spiders only, and c) ladybeetles only. The number of sites × crop stages over the three study years were 94, 86, and 57 for "Both predators", "Spiders", and "Ladybeetles", respectively. Our 352 predator isotope capsule samples included 252 spider capsules and 100 ladybeetle capsules, resulting in an average of $252/86 = 2.9$ predator capsules (data points) per site × stage × year in our model for

"Spiders", 100/57 = 1.8 predator capsules for "Ladybeetles", and 352/94 = 3.7 predator capsules for "Both predators". While the average number of capsules is not very high, it is higher than the 1.46 estimated by the reviewer.

2) Furthermore, please note that each predator isotope capsule may contain one or multiple predator individuals (depending on their dry weight), so the actual number of predator individuals involved in the stable isotope analysis was higher than the number of capsules, making our data more representative. In other words, each capsule may represent an average result for the predators.

3) The MCMCs in our Bayesian stable isotope mixing models all converged, indicating that the data inputs were adequate and the model results were reliable. Therefore, we feel that our interpretation of the results and the conclusions draw from them are appropriate.

4) As suggested by the reviewer, we have added the number of stable isotope capsules for the predators and prey sources to Table S1 to clarify the sample size issue.

3. This study has a similar methodology, results and conclusions as the one published in 2021 (https://doi.org/10.1002/ecs2.3625), which you cited as a data source. The larger difference in the methodology that I could recognize between this manuscript and the published study is that you collected over three years instead of one year. However, the middle year is the same in both studies. I am curious if you used the same dataset for the year 2018 in both studies or if you used other samples. If that is the case, it would be good to mention it.

[Reply]   We appreciate Reviewer 1 for carefully reading our manuscript. Yes, the raw data from the 2018 (Hsu et al. 2021) were included in this 3-year study (2017-2019), but were analyzed using different models to answer different research questions. As suggested, we have now mentioned this in the Materials and Methods section (*2.1. Study system and sample collection* in the main text).

Minor comments
4. Line 8: term "recent Anthropocene" could mean quite a large period, depending on who you ask. Rephrase it to the "recent decades".

[Reply]   We have revised this.

5. Line 17: As you decided not to focus on the seedling crop stage due to insufficient data (I am just not sure which data was insufficient, which could be mentioned in more detail), you can remove it from here.

[Reply]   Thank the reviewer for this suggestion. Please see our reply below:

1) In fact, we prepared stable isotope samples for arthropods collected at the seeding stage; however, the isotope data points were insufficient for reliable mixing model estimation of predators' diet composition (due to missing prey sources and a low number of predators).

We have now provided further clarification in the Materials and Methods section (*2.4. Data analyses* in the main text).

2) Although this study cannot reveal the predators' diet composition at the seedling stage, it still provides valuable arthropod abundance data for that stage (Fig. 4), which may be of interest to readers. This is why seedling stage is kept in this article.

6. Line 51-53: Missing citation for this sentence.

[Reply] Thanks for this suggestion. We have added two references:

1) Power, A. G. (2010). Ecosystem services and agriculture: tradeoffs and synergies. Philosophical transactions of the royal society B: biological sciences, 365(1554), 2959-2971.

2) Baker, B. P., Green, T. A., & Loker, A. J. (2020). Biological control and integrated pest management in organic and conventional systems. Biological Control, 140, 104095.

7. Line 111 - 113. This assumption (or hypothesis) was not elaborated here as to why you expected it.

[Reply] As suggested, we have explained the reason with the new sentence: "Although GAPs may consume various prey items, we expected them to consistently consume a high proportion of pests in their diet at late crop stages regardless of the year, due to the high pest densities in this period."

8. Line 257: I am missing any table with the results of the forest cover for each of the sites or pair of sites.

[Reply] We have added Table S4 to provide the forest cover information.

9. Line 330: "... for pest control in rice fields".

[Reply] We have revised it as suggested.

Reviewer 2's comments

1. This study presents diet analyses of spiders and ladybeetles over three years across organic and conventional rice farms, particularly investigating the proportion of pests in their diet over the season and across years. The authors use isotopes to assess diet. I am not an expert in these methods. The paper has collected an impressive dataset on predator diets, which is dearly missing from the natural pest control literature. I think it is very valuable work with a solid sampling design. However, the paper lacks ecological theory, and I have some concerns regarding the data analyses and thus interpretation of the results that need to be addressed before accepting this manuscript.

[Reply]   We thank Reviewer 2 for the positive feedback. Our point-by-point responses are listed below.

2. The introduction lacks **links to theory**, predator-prey cycles, and prey diversity-predation. The impact of seasonality (via changes in prey abundances, richness, intraguild predation), years, and of organic/conventional systems on diet composition needs to be better introduced and linked to current research. Currently, it lacks background, and the hypotheses are a bit weak.

[Reply]   We have strengthened these parts by adding or revising the following sentences:

1) "Moreover, fluctuations in abiotic factors and habitat conditions reportedly contribute to seasonal and yearly variations in prey density and species composition in agro-ecosystems (Dominik et al. 2018; Settle et al. 1996; Wardle et al. 1999), potentially influencing predator foraging behavior. Therefore, examining the consistency of pest consumption by generalist predators in the field over years is crucial to evaluate the stability of these predators as biocontrol agents in agriculture, although this information is lacking (knowledge gap 2)."

2) "To understand the mechanisms underlying the biocontrol effect of generalist predators, we also need to examine how their diet composition in agro-ecosystems is affected by various abiotic and biotic factors (e.g., crop stage, farm type, relative prey abundance, and surrounding vegetation) (knowledge gap 3). First, foraging behavior of generalist predators is strongly influenced by prey availability and species interactions (e.g., predator-prey interactions). Because arthropod community composition (e.g., pest vs. alternative prey density) may vary with crop stages and affect predator-prey trophic interactions (Roubinet et al. 2017), it is important to examine how crop stage affects the pest consumption by generalist predators within a growth season..."

3) "…Although GAPs may consume various prey items, we expected them to consistently consume a high proportion of pests in their diet at late crop stages regardless of the year, due to the high pest densities in this period. We also expected that the diet composition of GAPs would be affected by local abiotic and biotic factors, such as farm type (farming practice), crop stage, surrounding vegetation (percent forest cover), and the relative abundance of pests in the field..."

3. The **isotope method** used to assess diet needs to be introduced before the end of the introduction and compared to other available methods. What can we extrapolate using isotopes, and to what taxonomic level? As I am not an expert, it was very difficult for me to understand what this method can and cannot distinguish in terms of diet (presence/absence data, at the species/family level?).

[Reply]   As suggested, we have added more information about stable isotope analysis and moved this section earlier in the introduction. More details are provided below:

1) Regarding the question about taxonomic level, stable isotope analysis can be applied to estimate the diet composition of consumers at various ecological levels, such as individuals, populations, species, higher taxonomic levels, or trophic groups. For example, if a researcher is interested in estimating the average diet composition of the family Coccinellidae, s/he could analyze the stable isotopes of these consumers and their preys, and then run stable isotope mixing models to estimate the proportion of each prey item consumed in the diet of Coccinellidae. To reflect the reality, it is crucial to understand the consumer's ecology and include its primary preys in the analysis.

2) To provide a brief overview of stable isotope analysis, we have now included the following sentences in the introduction: "Stable isotope analysis has been widely applied in ecology to infer predator-prey trophic interactions and estimate the proportional contribution of different prey sources to predators' diets across various ecological levels, from individuals to trophic groups (Boecklen et al. 2011; Layman et al. 2012; Post 2002). Compared to "snap-shot" techniques (e.g., field observations and molecular gut content analysis), which primarily provide qualitative information about the presence or absence of prey items in predators' diets, stable isotope analysis (e.g., Bayesian stable isotope mixing models) quantifies the biomass proportion of different prey items in predators' diets over an extended time period (Newton 2016; Stock et al. 2018)."

4. **Classification of predators:** why consider ladybeetles as generalist predators? They are considered by natural pest control experts as predator specialists (Riggi et al., Ecological Indicators 2024). This is also the reason for the greater pest presence in their diets compared to more generalist and opportunistic predators such as spiders. Additionally, spiders constitute a varied group with different hunting modes that likely feed differently. As individuals were identified to species or families, this should be investigated (Sanders et al. 2015, https://besjournals.onlinelibrary.wiley.com/doi/pdf/10.1111/1365-2656.12271). This could lead to a more ecological approach to pest control and uncover mechanisms affecting diet composition by looking into traits: generalist versus specialist (spiders vs. ladybirds), hunting mode within spiders.

[Reply]   We thank the reviewer for asking these questions. Here are our explanations for considering ladybeetles and spiders as generalist predators:

1) While Riggi et al. (2024) classified coccinellids as specialist predators, they did not provide specific references for this. In fact, many studies on ladybeetle feeding ecology classify them as generalist predators (e.g., Rana et al. 2002, Mishra 2005, Evans 2009, Taylor & Snyder

2021), including a key review article on generalist predators as biocontrol agents (Symondson et al. 2002).

2) Furthermore, the dominant ladybeetle species of this study, *Micraspis discolor*, has been shown to feed on various crop pests such as aphids, brown plant hoppers, thrips, corn borers, scale insects, whiteflies, and mealy bugs (Begum et al. 2002, Shanker et al. 2013, Islam et al. 2016, Kumar et al. 2017). Therefore, we consider ladybeetles as generalist predators in this study.

3) We agree with the reviewer that spiders consist of groups with different hunting modes. The two main spider families in our rice system, Tetragnathidae and Araneidae, are generally web-building sit-and-wait predators (e.g., Nyffeler 1999, Sanders et al. 2015, Simonsen & Hesselberg 2021), particularly in rice farms (Ravi et al. 2022). Because our goal was to understand overall "guild-level" predator-pest trophic interactions, we pooled these two families into a single spider group for analysis. However, we acknowledge that predators with different hunting modes may interact differently with their prey in the field. Future studies could implement more detailed experimental designs to reveal within-guild variation in diet composition and its implications for pest consumption.

References:
Riggi, L. G., Aguilera, G., & Chopin, P. (2024). Expert-based model of the potential for natural pest control with landscape and field scale drivers in intensively managed cereal-dominated agricultural landscapes. *Ecological Indicators*, *159*, 111684.

Rana, J. S., Dixon, A. F. G., & Jarošík, V. (2002). Costs and benefits of prey specialization in a generalist insect predator. *Journal of Animal Ecology*, *71*(1), 15-22.

Mishra, G. (2005). Preference–performance of a generalist predatory ladybird: a laboratory study. *Biological Control*, *34*(2), 187-195.

Evans, E. W. (2009). Lady beetles as predators of insects other than Hemiptera. *Biological Control*, *51*(2), 255-267.

Taylor, J. M., & Snyder, W. E. (2021). Are specialists really safer than generalists for classical biocontrol?. *BioControl*, *66*(1), 9-22.

Symondson, W. O. C., Sunderland, K. D., & Greenstone, M. H. (2002). Can generalist predators be effective biocontrol agents?. *Annual review of entomology*, *47*(1), 561-594.

Begum, M. A., Jahan, M., Bari, M. N., Hossain, M. M., & Afsana, N. (2002). Potentiality of Micraspis discolor (F.) as a biocontrol agent of Nilaparvata lugens (Stal). *Journal of Biological Sciences*, *2*(9), 630-632.

Shanker, C., Mohan, M., Sampathkumar, M., Lydia, C., & Katti, G. (2013). Functional significance of M icraspis discolor (F.)(C occinellidae: C oleoptera) in rice ecosystem. *Journal of Applied Entomology*, *137*(8), 601-609.

Islam, M. Z., Labani, S. A., & Khan, A. B. (2016). Feeding Propensity and Cannibalism of Micraspis Discolor (Fab.) to Different Prey Species (Aphis craccivora and Nilaparbata lugens) under Laboratory. *Journal of Environmental Science and Natural Resources*, *9*(1), 81-85.

Kumar, M. S., Bandyopadhyay, U. K., Lalitha, N., & Saratchandra, B. (2017). Biology and feeding efficacy of Micraspis discolor, a potential biological control agent of whitefly Dialeuropora decempuncta. *Journal of Entomology and Zoology Studies*, *6*(1), 938-941.

Nyffeler, M. (1999). Prey selection of spiders in the field. *Journal of Arachnology*, 317-324.

Sanders, D., Vogel, E., & Knop, E. (2015). Individual and species-specific traits explain niche size and functional role in spiders as generalist predators. *Journal of Animal Ecology*, *84*(1), 134-142.

Simonsen, D., & Hesselberg, T. (2021). Unique behavioural modifications in the web structure of the cave orb spider Meta menardi (Araneae, Tetragnathidae). *Scientific Reports*, *11*(1), 92.

Ravi, G., Mohapatra, L. N., & Rahman, S. M. (2022). Ecological Guild and Predatory Behavior of Spider Fauna (Arachnida: Araneae) in Rice Agro Ecosystem. *Environment and Ecology*, *40*(2C), 1021-1027.

5. **Analyses:** Why prey and predator abundances in the field were not included in the model to see if the diet composition was representative of the absolute field abundances rather than the relative? Also to be able to interpret the results it would be relevant to check if prey abundances and predator abundances were affected by farming type*landscape and year as well, not only the diets.

[Reply] Please see our explanations for prey abundance, predator abundance, and their potential factors (e.g., farming type, landscape and year) below.

1) *Prey abundance* While our original model (beta GLMM) used relative prey abundance, we refitted the model using absolute prey abundance in the field as a predictor for "Both predators", "Spiders", and "Ladybeetles", as suggested by the reviewer. Overall, the model results remained qualitatively similar and did not alter our original conclusions:

	Relative abundance of rice herbivores	**Absolute abundance** of rice herbivores
Both predators	β ($\pm$ SE) = -0.23 ($\pm$ 0.35) χ^2 = 0.56, P = 0.46	β ($\pm$ SE) = -0.0006 ($\pm$ 0.0006) χ^2 = 0.90, P = 0.34
Spiders	β ($\pm$ SE) = 0.31 ($\pm$ 0.41) χ^2 = 0.58, P = 0.45	β ($\pm$ SE) = -0.00001 ($\pm$ 0.0008) χ^2 = 0.0002, P = 0.99
Ladybeetles	β ($\pm$ SE) = 0.13 ($\pm$ 0.22) χ^2 = 0.38, P = 0.54	β ($\pm$ SE) = 0.0003 ($\pm$ 0.0005) χ^2 = 0.35, P = 0.55

Given that a) the relative and absolute abundance analyses generate similar results, b) the relative abundance of prey can predict diet variation and prey switching in generalist predators (Coblentz 2020), c) the relative abundance of prey can be more important than absolute abundance in prey choice and consumption for acarine predators (Walde et al. 1995), and d) relative abundance offers a simple, standardized parameter that facilitates comparisons across studies, we believe that using relative abundance is a reasonable choice.

2) *Predator abundance* Thank the reviewer for this suggestion. We refitted our model using the absolute predator abundance as an additional predictor. The results showed no significant impact on pest consumption by predators (details below). Since our main objective is to

examine the effect of prey abundance on predators' diet composition, we have decided not to add predator abundance (not statistically significant) to our final model.

	Absolute predator abundance
Both predators	β ($\pm$ SE) = –0.009 ($\pm$ 0.006) χ^2 = 2.1, P = 0.14
Spiders	β ($\pm$ SE) = –0.001 ($\pm$ 0.007) χ^2 = 0.03, P = 0.87
Ladybeetles	β ($\pm$ SE) = –0.006 ($\pm$ 0.004) χ^2 = 2.7, P = 0.10

3) *Potential factors of prey and predator abundance (e.g., farming type, landscape and year)*
As suggested, we have now examined how predator abundance and rice herbivore abundance (number of individuals in field samples) are affected by year, farm type, crop stage, and percent forest cover (fixed effects), with farm ID nested within farm pair ID as a random effect. The number of observations in each year was used as weights in the models. The results show that predator abundance varied with years (2019 > 2017 and 2018) and crop stages (tillering > ripening > flowering) but not farm types and percent forest cover. Rice herbivore abundance also varied with years (2019 > 2017 and 2018) but not crop stages, farm types, and percent forest cover. We have reported these findings in the Supplementary Information (Appendix A: Table S5) for the following reasons: a) This information is not the primary focus of our study; b) This study was not specifically designed to survey predator and pest (rice herbivore) abundance, which would require greater sampling efforts to capture diverse and less common species; and c) Our main text is approaching the journal's word limit (7000 words).

Statistical results from GLMM models

Model	Factor	d.f.	χ^2	P
Predator abundance (both spiders and ladybeetles)	Year	2	64.2	< 0.001
	Farm type	1	0.006	0.94
	Crop stage	2	40.0	< 0.001
	Percent forest cover	1	1.8	0.18
Rice herbivore abundance	Year	2	30.2	< 0.001
	Farm type	1	0.63	0.43
	Crop stage	2	1.0	0.60
	Percent forest cover	1	2.8	0.10

Tukey's post-hoc tests comparing farm types

Model	Farm type	EMMs ($\pm$ SE)	Lower 2.5%	Upper 2.5%

		EMMs (± SE)	Lower 2.5%	Upper 2.5%
Predator abundance	Organic	7.6[a] (± 1.2)	5.7	10.3
	Conventional	7.7[a] (± 1.1)	5.8	10.3
Rice herbivore abundance	Organic	41.2[a] (± 8.1)	28.0	60.6
	Conventional	50.0[a] (± 9.8)	34.0	73.4

Tukey's post-hoc tests comparing crop stages

Model	Crop stage	EMMs (± SE)	Lower 2.5%	Upper 2.5%
Predator abundance	Tillering	13.8[a] (± 2.2)	10.2	18.8
	Flowering	4.4[b] (± 0.7)	3.2	6.1
	Ripening	7.4[c] (± 1.4)	5.2	10.6
Rice herbivore abundance	Tillering	39.8[a] (± 8.0)	26.8	59.0
	Flowering	48.0[a] (± 8.9)	33.4	69.0
	Ripening	48.9[a] (± 10.5)	32.1	74.6

References:

Coblentz, K. E. (2020). Relative prey abundance and predator preference predict individual diet variation in prey-switching experiments. Ecology, 101(1), e02911.

Walde, S. J., Magagula, C. N., & Morton, M. L. (1995). Feeding preference of *Zetzellia mali*: does absolute or relative abundance of prey matter more? Experimental & applied acarology, 19, 307-317.

6. **Abstract:** Lacks clarity in the methods (seedling stage was not analyzed, how many fields, what is meant by biotic/abiotic factors, how were the arthropods collected) and results (what do the percentages correspond to? what does higher mean?) and the conclusion is a bit vague.

[Reply]   We thank the reviewer for these suggestions and address the issues below.

1) As suggested, we now specify the number of fields, collecting methods, and abiotic/biotic factors. We also clarify our conclusion.

2) As explained above in this letter, some of our analyses do include the seedling stage (e.g., Fig. 4). This study clarifies in the Materials and Methods (*Data analysis* section) why the seedling stage was excluded from the diet analysis due to insufficient sample sizes.

3) Our abstract, although relatively concise, has reached the 350-word limit, leaving little room for additional details.

Specific Line Comments

7. L. 66: I do not agree that we still need to validate "spiders and ladybird biocontrol potential" – However, this paper could bring a better understanding of how pest and prey abundances affect diet composition and stability. Same L.91

[Reply] We appreciate this comment and have modified the sentence: "While the value of generalist predators has been increasingly appreciated, a few fundamental knowledge gaps need to be filled to better understand their biocontrol potential and the underlying mechanisms in agro-ecosystems."

8. L. 78: Consider replacing reliability with stability or variability.

[Reply] As suggested, we now use the word "stability".

9. L. 85: What is meant by abiotic and biotic factors?

[Reply] We have now specified these factors: "To understand the mechanisms underlying the biocontrol effect of generalist predators, we also need to examine how their diet composition in agro-ecosystems is affected by various abiotic and biotic factors (e.g., crop stage, farm type, relative prey abundance, and surrounding vegetation) (knowledge gap 3)."

10. L. 93: Can you define what you mean by diet/consumption composition?

[Reply] We have modified an earlier sentence in the Introduction to define diet composition more clearly: "Quantifying diet composition (e.g., the proportions of different prey items in the predators' diet) will help address concerns that generalist predators may switch their diet from pests to alternative prey or interfere with each other (e.g., intraguild predation), thereby reducing their pest control effectiveness (Cuff et al. 2022; Hambäck et al. 2021; Michalko, Pekár & Entling 2019)."

11. L. 113: Unclear hypothesis. I would expect that predation by generalists would depend mostly on pest abundances rather than crop stages.

[Reply]
1) We don't have enough background information to form a specific hypothesis. Therefore, we provided our expectation on this topic: "We also expected that the diet composition of GAPs would be affected by local abiotic and biotic factors, such as farm type (farming practice),

crop stage, surrounding vegetation (percent forest cover), and the relative abundance of pests in the field."

2) Yes, we agree that the dietary patterns of generalist predators are largely governed by prey abundance. However, farm factors such as farming practices and crop stage can also influence predator foraging behavior by altering prey availability in the field. In particular, prey composition and pest abundance can change substantially over crop stages, likely resulting in various pest consumption by predators across crop stages.

12. L. 117: What do you mean by proportional contribution? Different prey sources? Define (is this per predator individual or per group).

[Reply]
1) Stable isotope mixing models estimate the biomass proportions of different prey items (sources) in predators' diet based on the isotope signatures of both prey and predators (e.g., 30% of the total prey biomass consumed by the predator comes from prey A, 50% from prey B, and 20% from prey C). Whether the results apply to an individual predator or predator feeding guild depends on the samples analyzed. For example, analyzing multiple predator species can infer the diet composition of a predator feeding guild.

2) We have revised the Introduction to better explain stable isotope analysis: "Stable isotope analysis has been widely applied in ecology to infer predator-prey trophic interactions and estimate the proportional contribution of different prey sources to predators' diets across various ecological levels, from individuals to trophic groups (Boecklen et al. 2011; Layman et al. 2012; Post 2002). Compared to "snap-shot" techniques (e.g., field observations and molecular gut content analysis), which primarily provide qualitative information about the presence or absence of prey items in predators' diets, stable isotope analysis (e.g., Bayesian stable isotope mixing models) quantifies the biomass proportion of different prey items in predators' diets over an extended time period (Newton 2016; Stock et al. 2018)."

13. Very nice design but missing the number of fields sampled in pairs.

[Reply] We appreciate the reviewer's positive comment. The information is actually provided in our Materials and Methods (*2.1. Study system and sample collection*): "We collected terrestrial arthropods in paired organic and conventional rice farms in subtropical Taiwan (120.656-120.721 °E; 24.364-24.489 °N) from 2017 to 2019 (three farm pairs in 2017 and seven farm pairs each in 2018 and 2019)."

14. Consider including a map.

[Reply] We appreciate the reviewer's comment and have added a new Figure 1 to include the study site map, experimental design, and crop stages.
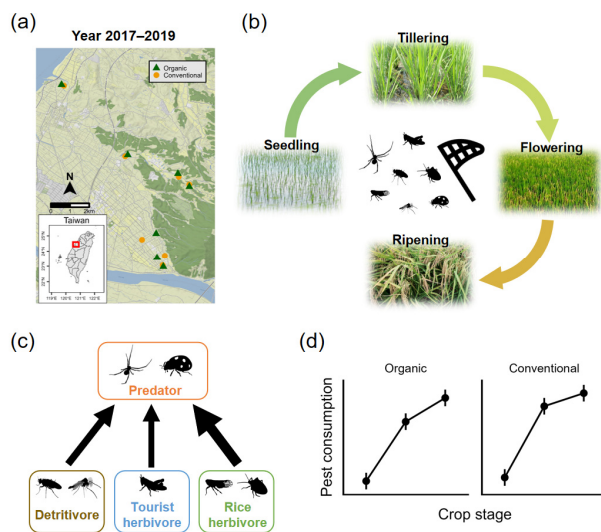
18

Figure 1. Sampling design and analyses of the study: (a) Map of the paired organic and conventional rice farms across the three study years (three farm pairs in 2017 and seven farm pairs in 2018 and 2019). The red rectangle in the inset map indicates the region in central Taiwan where the farms were located. (b) Arthropods were sampled in each rice farm at four major crop stages (seedling, tillering, flowering, and ripening) using the sweep net method. (c) Field arthropod samples were categorized into three prey guilds (rice herbivores, tourist herbivores, and detritivores) and one predator guild. Stable isotope analysis was used to quantify the proportions of these prey sources in predators' diets. (d) The proportion of rice herbivores (pests) consumed by predators, derived from (c), was analyzed to examine how pest consumption by predators varied with farm type, crop stage, percent forest cover, and the relative abundance of rice herbivores in the field.

15. Include information on landscape factors around the pairs (min/max/mean/sd).

[Reply] We have now provided the percent forest cover for all 7 farm pairs in Appendix A (Table S4).

16. Include a sampling design in the appendix and maybe figures of the different stages.

[Reply] As suggested, we now add Figure 1 to include the study site map, experimental design, and crop stages.

17. Were the samples from each transect merged?

[Reply] Yes, the arthropod samples from the two transects in each farm were pooled to represent the entire farm. To clarify this, we have added the following sentence to the Materials and Methods section: "The arthropod samples from the two transects in each farm were pooled to represent the farm."

18. Organisms were counted and identified in each transect? This is amazing data, and I do not understand why in the analyses: Spiders were all blended into one single group? Use traits or family level to investigate diets in more detail.

[Reply] Yes, arthropod samples from the two transects were pooled and later identified to the family level (or to genus level if possible). The two main spider families in our rice system, Tetragnathidae and Araneidae, were combined into a single spider group for analysis, as our goal was to understand overall "guild-level" patterns in predator-pest trophic interactions. That being said, we agree that future studies could implement a more detailed experimental design to reveal within-guild variation in diet composition and its implications for pest consumption. Please see our response to Reviewer 2's comment 4 for more details.

19. Prey and predator abundances in the field were not included in the model to see if the diet composition was representative of the absolute field abundances rather than the relative?

[Reply]   Yes, this study used relative abundance. Please see more details in our response to Reviewer 2's comment 5.

20. Why were prey grouped? Could network analyses not be used? What is the taxonomic level that can be distinguished using isotope analyses? And what is the data coming out (is it like molecular gut content absence/presence)?

[Reply]
1) *Prey groups*   Stable isotope mixing models estimate the proportions of different resources in consumers' diet. Generally, the models can reliably estimate dietary proportions for at most n+1 resources if there are n isotope elements. In our study, we have two isotopes (^{13}C and ^{15}N), allowing us to input three prey sources into the models as food resources for predators. Since our field samples included many prey families (Appendix A: Table S1), we grouped them into three trophic guilds (trophic species) and use these three prey guilds to estimate predators' diet composition. Please see more details in the Materials and Methods section (*2.3. Arthropod trophic guild assignment*).

2) *Network analysis*   Stable isotope analysis and network analysis can be related but serve different purposes. For example, stable isotope analysis helps identify diet composition and trophic interactions (edge) of a species (node). Network analysis, on the other hand, uses the edge and node information to explore food web structure properties.

3) *Taxonomic level*   As we explained above regarding the predator level (in our response to Reviewer 2's comment 12), the taxonomic level of prey used in mixing models depends on the research questions. It can range from focusing on individual prey to prey guilds.

4) *Data output*   The output of stable isotope mixing models estimates the proportion of different prey sources (items) in predators' diet. For example, the results may show that 30% of the total prey biomass consumed by a predator comes from prey A, 50% from prey B, and 20% from prey C. To clarify the difference between molecular gut content analysis and stable isotope analysis, we have included this sentence in our Introduction section: "Compared to "snap-shot" techniques (e.g., field observations and molecular gut content analysis), which primarily provide qualitative information about the presence or absence of prey items in predators' diets, stable isotope analysis (e.g., Bayesian stable isotope mixing models) quantifies the biomass proportion of different prey items in predators' diets over an extended time period (Newton 2016; Stock et al. 2018)."

21. L. 147: How common was it to add several conspecifics to one capsule? I wonder then what the percentage means, as I imagine smaller species will need to be more often combined than larger ones. Doesn't that create a bias? Why not use a % per biomass rather than % per capsule? Unclear how this was dealt with.

[Reply]

1) Stable isotope analysis requires a minimum amount of dry tissue to make reliable estimates (please see examples from https://stableisotopefacility.ucdavis.edu/sample-weight-calculator). In our study, except for a few large-bodied families like Acrididae, we generally oven-dried several individuals, pulverized them, and weighed around 2 mg of dry tissue for each isotope capsule. For smaller-bodied families, more individuals were needed to meet the minimum weight requirement. This adjustment was made to ensure accurate stable isotope signatures for prey items. It will not introduce bias to our diet composition estimation because the estimation depends on the stable isotope signatures of predators and prey. Additionally, we prepared multiple isotope capsules for each predator or prey family, when possible, to further reduce potential sampling bias.

2) The isotope capsules samples were combusted in an analyzer to measure the ^{13}C and ^{15}N contents. Because these values are extremely small in absolute terms, they are expressed as isotopic deviations from the international standards (denoted as delta δ values) with units of per mille (‰). Please see the website for more explanations on stable isotope analysis (https://www.nature.com/scitable/knowledge/library/the-use-of-stable-isotopes-in-the-96648168/).

22. L. 156: Please provide a table with the species in each category.

[Reply]   Yes, we did provide this in our Appendix A: Table S1.

23. L. 162: I am not clear how you can distinguish between the species (rice pests and other herbivores).

[Reply]   The assignment of rice herbivores (pests) and other herbivores (tourist herbivores) was based on a combination of literature surveys and k-means clustering of their stable isotope signatures. More details are available in our Materials and Methods (*2.3. Arthropod trophic guild assignment*). In general, we first searched the literature for the diets of the herbivore families/genera and then validated the information by analyzing their stable isotope signatures. Rice herbivores and tourist herbivores can be distinguished in an isotope biplot (Appendix A: Fig. S1) because they feed on plant sources with different isotope signatures — rice plant consumed by rice herbivores is C3, while the grasses commonly consumed by tourist herbivores in the surrounding vegetation are C4.

24. L. 163: Instead of tourist herbivore, replace it with "alternative prey."

[Reply]   Thanks for the suggestion. We feel that using the term "tourist herbivore" in this study is appropriate because there are two alternative prey guilds in our study system: "tourist herbivore" and "detritivore". It is important to distinguish them since they consume different food items. Specifically, tourist herbivores typically consume surrounding vegetation, while detritivores consume decaying materials.

25. L. 178: What are "mixing models"?

[Reply]   Stable isotope mixing models estimate the diet of a consumer (individual or group) based on the isotope signatures of their tissues and food sources (Parnell et al. 2013). These models differ from mixed models, which are statistical models for assessing the effects of predictors on response variables.

Reference:
Parnell, A. C., Phillips, D. L., Bearhop, S., Semmens, B. X., Ward, E. J., Moore, J. W., ... & Inger, R. (2013). Bayesian stable isotope mixing models. Environmetrics, 24(6), 387-399.

26. L. 178: I am not sure I understand why Bayesian was needed. I am not familiar with these methods, and a little introduction on what these methods do and why using this would be nice. Also, why not include a random factor? Farm ID and farm pair?

[Reply]
1) We used the R package MixSIAR for our mixing model analysis. The package employs a Bayesian approach to estimate the dietary proportions of predators. The Bayesian framework offers the advantage of incorporating prior information and various sources of uncertainty in diet estimation.

2) To introduce the advantage of Bayesian approach, we now add this sentence to the Materials and Methods (*2.4. Data analyses*): "The Bayesian framework allows for the incorporation of prior information on the diets of predators as well as various sources of uncertainty in the diet estimation (Moore & Semmens 2008; Parnell et al. 2013)."

3) Yes, our analysis includes "farm ID nested within farm pair ID as a random effect" in our beta regression models. Please see more details in our Materials and Methods (*2.4. Data analyses*).

References:
Moore, J. W., & Semmens, B. X. (2008). Incorporating uncertainty and prior information into stable isotope mixing models. Ecology letters, 11(5), 470-480.

Parnell, A. C., Phillips, D. L., Bearhop, S., Semmens, B. X., Ward, E. J., Moore, J. W., ... & Inger, R. (2013). Bayesian stable isotope mixing models. Environmetrics, 24(6), 387-399.

27. L. 183: What is C and N dependencies? That sentence is not clear.

[Reply]   Because C and N contents vary among organisms, incorporating this source of variation into the mixing models helps improve the accuracy of the diet estimates. We have modified this sentence in the Materials and Methods section (*2.4. Data analyses*): "To improve our model estimates, we incorporated carbon and nitrogen concentration dependencies (C and N contents of the isotope samples) as well as the residual/process errors (Phillips & Koch 2002; Stock & Semmens 2016)."

28. L. 185: What is a trophic discrimination factor?

[Reply]   A trophic discrimination factor (TDF Δ) is defined as the difference in isotopic values between the prey source and the consumer. This isotopic difference arises from fractionation,

which is the preferential utilization of lighter over heavier isotopes of an element in organisms' tissues. As a result, $\delta^{13}C$ and $\delta^{15}N$ values increase at higher trophic levels. Stable isotope mixing models require TDFs to adequately account for such changes in $\delta^{13}C$ and $\delta^{15}N$ when estimating consumers' diet compositions. We now provide this TDF information (Appendix A: Table S7) since it also relates to Reviewer 3's comment 10 (below).

29. L. 188: Add reference.

[Reply] As suggested, we have added the reference:

Stock, B.C., Jackson, A.L., Ward, E.J., Parnell, A.C., Phillips, D.L. & Semmens, B.X. (2018) Analyzing mixing systems using a new generation of Bayesian tracer mixing models. Peerj, 6.

30. L. 189: Add reference.

[Reply] We have added the reference:

Gelman, A. & Rubin, D.B. (1992) Inference from iterative simulation using multiple sequences. Statistical science, 7, 457-472.

31. L. 193: Why not include year as an interaction with farm type if you are interested in stability over time? Also, I am not sure why you use relative abundance rather than absolute? And why not include predator abundances?

[Reply] We appreciate the comments on model fitting. Please see our responses below:

1) *Farm type*Year interaction* We did not include this interaction in the beta GLMMs because we were less interested in whether the difference in pest consumption by predators in organic vs. conventional farms (i.e., the effect of farm type) varied across the three study years. Instead, our main interest was in whether the overall pest consumption patterns in both organic and conventional farms varied across years. Therefore, we included only the main effect of year in the models.

2) *Relative vs. absolute abundance of rice herbivores* This study used the relative abundance instead of absolute abundance of rice herbivores in the GLMMs. While the results are qualitatively similar, please see the detailed explanations in our response to Reviewer 2's comment 5.

3) *Predator abundance* As suggested, we refitted the GLMMs with the absolute predator abundance (i.e., the number of predator individuals in our field samples) as an additional predictor. The results show that predator abundance is not a significant factor. Please see more details in our response to Reviewer 2's comment 5.

32. I would be interested to know if prey abundances and predator abundances were affected by farming type*landscape and year as well, not only the diets.

[Reply]   We have added this analysis and reported the results in the Supplementary Information (Appendix A: Table S5). Please see more details in our response to Reviewer 2's comment 5.

[Reply]   Thank the reviewer for pointing out this. Our analyses consist of two parts: 1) Predator and prey stable isotope analysis & mixing model analysis of predators' diet composition, with predator and prey samples as replicates; 2) Patterns of pest consumption by predators in rice agro-ecosystems, with crop stage × study farm as replicates. We have revised our replication statement accordingly:

Scale of inference	Scale at which the factor of interest is applied	Number of replicates at the appropriate scale
Predator and prey stable isotope analysis & mixing model analysis for predators' diet composition	Predator, rice herbivore, tourist herbivore, and detritivore individuals collected at each rice stage in organic and conventional farms over three study years	352 predator stable isotope samples (capsules) 828 prey stable isotope samples (capsules)
Patterns of pest consumption by predators in rice agro-ecosystems	Proportion of rice herbivores (pests) in predators' diet at each rice stage in organic and conventional farms over three study years	Year 1: 3 crop stages × 6 farms Year 2: 3 crop stages × 14 farms Year 3: 3 crop stages × 14 farms

[Reply]
1) The first section of the results (*3.1. Diet composition of predators in rice farms*) presents the proportion of various prey in the predators' diet and is therefore more descriptive. Standard errors are provided in Appendix A: Table S2.

2) The remain sections of the results (*3.2. Patterns of rice herbivore consumption by predators & 3.3. Factors associated with rice herbivore consumption by predators*) include more analytical statistics.

[Reply]   This statement simply describes the common patterns across three study years in Fig. 3, where pest consumption by predators increases over the rice growth season in all three years. We have now clarified this in the revised sentence: "We further analyzed rice herbivore

consumption by GAPs since these herbivores are the primary pests of concern. The patterns of rice herbivore consumption by both predators in organic and conventional rice farms were generally similar across the three study years: Consumption increased and reached a high proportion during the late crop stages, indicating consistency in the feeding habits of GAPs (Fig. 3).”

36. Fig. 2: No measure of variance?

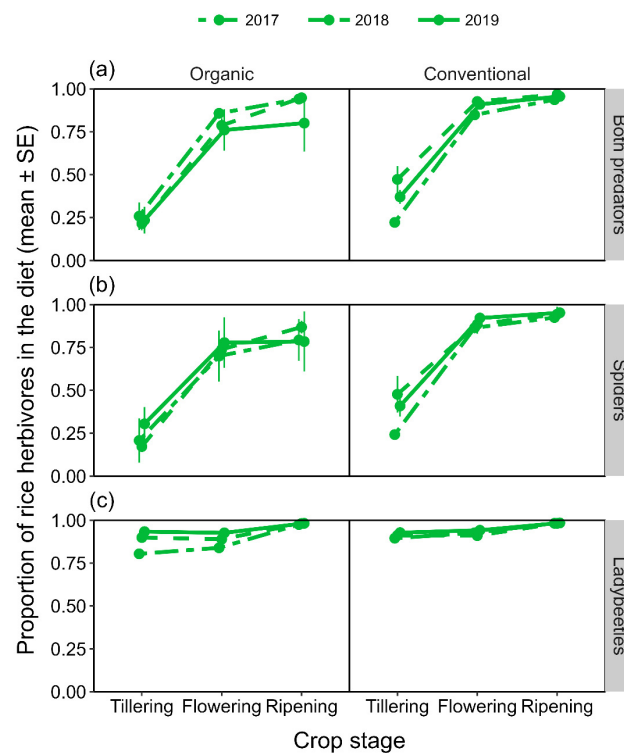**[Reply]** We have added the error bars to this figure (new Fig. 3).

Figure 3. The proportion (mean ± SE) of rice herbivores consumed in the diet of (a) both predators, (b) spiders, and (c) ladybeetles in organic and conventional rice farms over crop stages in the three study years. The proportions were computed from the Bayesian posterior medians of diet estimates in replicate farms.

37. L. 285: You cannot state that the spiders become more specialist as you do not include the different group abundances. They might be eating the same proportionally to what is in the field. Rephrase manuscript title accordingly

[Reply]
1) Stable isotope analysis shows that the proportion of rice herbivores (pests) in the generalist predators’ diet increased with crop stages, from 21-47% at the tillering stage to 80-97% at the ripening stage. Therefore, we state that these generalist predators “function” as pest specialists at late crop stages.

25

2) We agree with the reviewer that the diet composition of generalist predators may reflect what is available in the field. However, the beta regression models in this study show no effect of pest abundance on pest consumption by predators (Table 1; please also see our response to Reviewer 2's comment 5). This suggests that these predators might be consuming more rice pests in their diets than what they would have by random foraging. Regardless of the underlying mechanisms, these predators consumed a high proportion (80-97%) of rice pests in their diet at late crop stages and therefore "function" like pest specialists.

Reviewer 3's comments

1. This study aims to analyse the diet composition of spiders and ladybeetles over the growth season in rice crops. The authors used stable isotope analysis and Bayesian mixing models to identify predator preferences for pests and other herbivores over 3 years of study. In addition, the study intends to cover different gaps of knowledge related to the effect of biotic and abiotic factors (cropping regime, abundance of pests, and complexity of surrounding vegetation) on predator diet composition.

The manuscript is well written and the ideas set out clearly and concisely. I believe that the topic is timely and necessary to elucidate whether generalist predators can be considered natural enemies in crops within the framework of biological pest control. However, the authors focus on highlighting the potential benefits that the presence of generalist predators can bring to pest control in the crop (which I agree with) but it is not until late in the discussion that they refer to feeding behaviours such as intraguild predation, very common in predators such as spiders, which can have a negative effect on biological pest control. In fact, this is the main problem I find with both the sample collection design and the Bayesian mixing model analysis. The authors have focused on analysing the diet composition of predators based on the study of the isotopic content of different herbivores present in the rice crop. However, Bayesian mixing models are very sensitive to missing resources and, considering the great diversity of resources available to spiders, it would be necessary to include other potential non-herbivore prey in the analysis. On the other hand, they use the method proposed by Caut et al. (2009) to calculate TDFs but this protocol was subsequently criticised in several publications and is therefore not the most suitable to be used. In my opinion these are important changes that should be resolved before publishing the manuscript.

[Reply] We thank Reviewer 3 for the positive feedback and constructive comments. Regarding the issues with stable isotope mixing models (e.g., intraguild predation) and TDFs, we have addressed them in our response to Associate Editor's comments (above) and in the following section.

Key words

2. Please remove the keyword "generalist predators" because it is included in the title.

[Reply] As suggested, we have removed this keyword.

Introduction

3. The introduction is concise and clearly explains the gaps in knowledge of generalist natural enemies as biological control agents and why it is important to fill these gaps in order to increase the importance of generalist predators in biological pest control programs. However, I believe that the authors do not expose to an adequate extent the potential drawback of intraguild predation and the impact that using generalist predators, such as spiders, can have on other natural enemy populations. There are recent articles that claim for further studies that deeply investigate the pros and cons of spider as natural enemies in crops and, despite I understand that it is not the aim of the manuscript, I consider that it would be good to make a reference to this issue.

For instance, Hanbäck et al. (2021) found that an important part of the diet of several spider families was covered by other natural enemies in apple orchards. In addition, Mezofi et al. (2020) showed that the beneficial provided by arboreal spiders as predators of aphids in apple crops is reduced by their high levels of intraguild predation and by a propensity to switch from pests to alternative prey. Saqib et al. (2021) demonstrated the great dietary spectrum of different spider families in Brassica vegetable orchards. Authors highlight the complexity of these predator networks but found some preferences and biological control potential of particular spider taxa.

Hambäck, P. A., Cirtwill, A. R., García, D., Grudzinska-Sterno, M., Miñarro, M., Tasin, M., ... & Samnegård, U. (2021). More intraguild prey than pest species in arachnid diets may compromise biological control in apple orchards. Basic and Applied Ecology, 57, 1-13.
Mezőfi, L., Markó, G., Nagy, C., Korányi, D., & Markó, V. (2020). Beyond polyphagy and opportunism: natural prey of hunting spiders in the canopy of apple trees. PeerJ, 8, e9334.
Saqib, H. S. A., Liang, P., You, M., & Gurr, G. M. (2021). Molecular gut content analysis indicates the inter-and intra-guild predation patterns of spiders in conventionally managed vegetable fields. Ecology and Evolution, 11(14), 9543-9552.

[Reply]   We appreciate the reviewer for providing valuable references. While intraguild predation is not the main focus of this study, we agree that additional information on this topic would enhance the depth of this study. Therefore, we have included the suggested references and modified or added the following sentences in the Introduction and Discussion sections:

Introduction section:
"Quantifying diet composition (e.g., the proportions of different prey items in the predators' diet) will help address concerns that generalist predators may switch their diet from pests to alternative prey or interfere with each other (e.g., intraguild predation), thereby reducing their pest control effectiveness (Cuff et al. 2022; Hambäck et al. 2021; Michalko, Pekár & Entling 2019)."

Discussion section *(4.4. Potential caveats of this study)*:
"…Second, while intraguild predation potentially influences the pest control by GAPs (Michalko, Pekár & Entling 2019; Straub, Finke & Snyder 2008), it was not quantified in our diet composition analysis. Intraguild predation can compromise pest control by predators. For example, hunting spiders in apple orchards exhibit high levels of intraguild predation, thereby

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reducing pest control (Hambäck et al. 2021; Mezőfi et al. 2020). We did not quantify intraguild predation in our diet composition analysis because we were unable to accurately distinguish predator individuals engaging in intraguild predation from those that did not in the stable isotope mixing models. However, this may not be a major concern in our study because of the following reasons: 1) Rice plants grow in dense clumps, especially at late crop stages (Fig. 1b), forming a complex structure that likely reduces intraguild predation pressure (Finke & Denno 2006; Janssen et al. 2007); 2) The primary spider families in our study were web-building sit-and-wait predators, which are less prone to intraguild predation (Denno et al. 2004); 3) The $\delta^{15}N$ values of predators were close to those of rice herbivores (Fig. S1), suggesting that if intraguild predation occurred, it was likely minor; otherwise, predators' $\delta^{15}N$ values would be higher. Nevertheless, we caution that our diet estimates of predators (without predator-predator interference) might not apply to systems where intraguild predation prevails."

4. L 57-60: Authors emphasize the increasing importance of generalist predators in biological pest control. I agree with authors but it would be important to highlight that in the case of spiders, there are many misgivings about its efficacy as a biological agent due to its cannibalistic behaviour and its ability to feed on other natural enemies present in the crop. The list of references would be enriched by including recent articles in which spiders have been experimentally identified as potential natural enemies of crop pests:

Morente, M., & Ruano, F. (2022). Understanding the trophic relationships amongst arthropods in olive grove by $\delta N15$ and $\delta C13$ stable isotope analysis. Journal of Applied Entomology, 146(4), 372-384.

Mezőfi, L., Markó, G., Nagy, C., Korányi, D., & Markó, V. (2020). Beyond polyphagy and opportunism: natural prey of hunting spiders in the canopy of apple trees. PeerJ, 8, e9334.

Cuff, J. P., Tercel, M. P., Drake, L. E., Vaughan, I. P., Bell, J. R., Orozco-terWengel, P., ... & Symondson, W. O. (2022). Density-independent prey choice, taxonomy, life history, and web characteristics determine the diet and biocontrol potential of spiders (Linyphiidae and Lycosidae) in cereal crops. Environmental DNA, 4(3), 549-564.

[Reply]   Thank Reviewer 3 for providing these references. We have now modified our sentences in the Introduction and Discussion sections to include these references.

Introduction section:
"Quantifying diet composition (e.g., the proportions of different prey items in the predators' diet) will help address concerns that generalist predators may switch their diet from pests to alternative prey or interfere with each other (e.g., intraguild predation), thereby reducing their pest control effectiveness (Cuff et al. 2022; Hambäck et al. 2021; Michalko, Pekár & Entling 2019)."

"For example, generalist predators were commonly reported in various agro-ecosystems (Cuff et al. 2022; Mezőfi et al. 2020; Morente & Ruano 2022) and significantly reduced pest abundance in approximately 75% of cases in 181 field manipulative studies (Symondson, Sunderland & Greenstone 2002)."

Discussion section:
"Intraguild predation can compromise pest control by predators. For example, hunting spiders in apple orchards exhibit high levels of intraguild predation, thereby reducing pest control (Hambäck et al. 2021; Mezőfi et al. 2020)."

5. L 72-76: The same as above. It is important to consider not only the facility of generalist predators to change their preys but which is the function of these preys in the crop.

[Reply]   We agree and have revised our sentences in the Introduction section:

"Moreover, fluctuations in abiotic factors and habitat conditions reportedly contribute to seasonal and yearly variations in prey density and species composition in agro-ecosystems (Dominik et al. 2018; Settle et al. 1996; Wardle et al. 1999), potentially influencing predator foraging behavior. Therefore, examining the consistency of pest consumption by generalist predators in the field over years is crucial to evaluate the stability of these predators as biocontrol agents in agriculture, although this information is lacking (knowledge gap 2)."

6. L 113: Please change: "regardless of the year"

[Reply]   We have changed this as suggested:

"Although GAPs may consume various prey items, we expected them to consistently consume a high proportion of pests in their diet at late crop stages regardless of the year, due to the high pest densities in this period."

7. L 137: Please add a space between 1.5 and m.

[Reply]   We have added a space as suggested:

"Each transect (ca 30 m long) was parallel to but 1.5 m away from a randomly selected farm ridge."

8. L 147-149: Could you be more explicit, how many capsules did you use per taxon (e.g. range, mean number or total number)? I suggest adding the number of capsules in Table S1.

[Reply]   We appreciate this suggestion and have added the number of capsules to Table S1.

9. L 175-178: I acknowledge the enormous work done by the authors in collecting and analysing a large number of herbivore taxa over several years and in different types of cropping regimes. However, as I have pointed out before, in the case of spiders I am concerned about the effect of intraguild predation and cannibalism on the results of the Bayesian mixing model. Mixing models are sensitive to missing sources (Phillips et al. 2014) and in the case of spiders, I consider it mandatory to include the stable isotope signature of prey other than the herbivore (spiders and other non-spider predators) that might be important in the diet composition of predators mainly in those seasons when pests and other herbivores are scarce. I recommend including in the

analysis those predators that show a stable isotopic signature that fits the mixing polygon defined by the sources (in the C-N graph) and that have been previously identified as prey of the predators studied in the literature.

Phillips, D. L., Inger, R., Bearhop, S., Jackson, A. L., Moore, J. W., Parnell, A. C., ... & Ward, E. J. (2014). Best practices for use of stable isotope mixing models in food-web studies. Canadian Journal of Zoology, 92(10), 823-835.

[Reply]   We thank Reviewer 3 for this suggestion. As suggested, we ran an additional mixing model to include predators as an extra prey source. The results show minimum involvement of intraguild predation. Please see our detailed analysis and explanation in the response to the Associate Editor's comment 2 (*"Include other potential non-herbivore prey in the Bayesian mixing model analysis, considering the complex diet of predators like spiders."*).

10. L 185-186: Caut et al. (2009) proposed that TDFs vary systematically based on the isotopic values of the diet, but this conclusion has been criticized for the lack of a theoretical and mechanistic basis and also because of mathematical artefacts and experimental biases (Auerswald et al. 2010; Perga and Grey 2010; Codron et al. 2012). Thus, I'm afraid that it is probably not the best option to use for calculating TDFs.

TDFs are one of the most uncertain factors in order to analyse organism's diet by isotopic analyses. Currently, the best proposed way to estimate TDFs is to conduct controlled studies of consumer-diet N15 and C13 enrichment by isolating the predators of interest with their main prey and analysing their isotopic content at various times after it has been fed. However, I consider that this method is restricted to very specific studies and is not feasible for field studies with generalist predators. In this case, you can search the literature for TDFs previously used for your taxa of interest. If this option is not possible, the third (and least reliable) way is to use pre-established TDFs for predatory insects and spiders (e.g. McCutchan et al., 2003, Vanderklift & Ponsard, 2003).

Auerswald, K., Wittmer, M. H., Zazzo, A., Schäufele, R., & Schnyder, H. (2010). Biases in the analysis of stable isotope discrimination in food webs. Journal of Applied Ecology, 47(4), 936-941.
Perga, M. E., & Grey, J. (2010). Laboratory measures of isotope discrimination factors: comments on Caut, Angulo & Courchamp (2008, 2009). Journal of Applied Ecology, 47(4), 942-947.
Codron, D., Sponheimer, M., Codron, J., Newton, I., Lanham, J. L., & Clauss, M. (2012). The confounding effects of source isotopic heterogeneity on consumer–diet and tissue–tissue stable isotope relationships. Oecologia, 169, 939-953.
McCutchan Jr, J. H., Lewis Jr, W. M., Kendall, C., & McGrath, C. C. (2003). Variation in trophic shift for stable isotope ratios of carbon, nitrogen, and sulfur. Oikos, 102(2), 378-390.
Vanderklift, M. A., & Ponsard, S. (2003). Sources of variation in consumer-diet δ15N enrichment: a meta-analysis. Oecologia, 136, 169-182.

[Reply]

1) Thank the reviewer for providing these comments and references. Yes, an ideal way to derive TDFs is through feeding experiment. However, this is not feasible for our field study. Therefore, we derived TDFs using the equations from Caut et al. 2009.

2) As suggested, we searched the literature for published TDFs for our predator taxa. We found several studies on spiders that used the typical TDFs for terrestrial consumers from McCutchan et al. (2003) (e.g., Mestre et al. 2013, Haraguchi et al. 2013, Sanders et al. 2014). We also found one study that published TDFs for the lycosid spider feeding on aphids, *Drosophila*, and Collembolans (Oelbermann and Sechu 2002):

Predator	Prey	$\Delta^{13}C$	$\Delta^{15}N$	Reference
Terrestrial consumers	Invertebrates	0.50 ± 0.13	1.40 ± 0.20	McCutchan et al. 2003
Lycosid spider	Aphids	1.38 ± 0.22	1.50 ± 0.39	Oelbermann and Sechu 2002
Lycosid spider	*Drosophila*	-0.38 ± 0.10	2.16 ± 0.43	Oelbermann and Sechu 2002
Lycosid spider	Collembolans	0.02 ± 0.03	2.53 ± 0.09	Oelbermann and Sechu 2002

3) We performed a sensitivity analysis (e.g., Sanders et al. 2014) using the following new TDFs for the three prey sources to estimate the diet composition of predators (the parameter settings for the stable isotope mixing model remained consistent with those in our original analysis):

For rice herbivore TDFs, we used the TDFs for Lycosid spider feeding on aphids from Oelbermann and Sechu (2002) because many of our rice herbivores are sap feeder, similar to aphids.

For tourist herbivore TDFs, we calculated the mean of the TDFs for Lycosid spider feeding on aphids (Oelbermann and Sechu 2002) and the TDFs for terrestrial consumers from McCutchan et al. (2003). We did not use the TDFs for Lycosid spider feeding on aphids because our tourist herbivores are not sap feeders but chewers.

For detritivore TDFs, we calculated the mean of the TDFs for Lycosid spider feeding on *Drosophila* from Oelbermann and Sechu (2002), the TDFs for Lycosid spider feeding on Collembolans from Oelbermann and Sechu (2002), and the TDFs for terrestrial consumers from McCutchan et al. (2003). This is because our detritivores include flies and other dipterans, such as chironomidae. Although we did not collect collembolans in our samples, they feed on decaying materials, similar to our detritivores. Therefore, we included them in the calculation of new detritivore TDFs:

Prey sources	Original TDFs (based on Caut et al. 2009)		New TDFs (based on Oelbermann and Sechu 2002, McCutchan et al. 2003)	
	$\Delta^{13}C$	$\Delta^{15}N$	$\Delta^{13}C$	$\Delta^{15}N$
Rice herbivore	1.1 ± 0.5	2.4 ± 0.6	1.38 ± 0.22	1.50 ± 0.39
Tourist herbivore	0.7 ± 0.6	2.1 ± 0.7	0.94 ± 0.18	1.45 ± 0.30
Detritivore	0.9 ± 0.3	1.5 ± 0.9	0.05 ± 0.09	2.03 ± 0.24

4) The model results based on the new TDFs listed above were generally similar to our original results (top vs. bottom figures below), suggesting that our findings are robust to variations in TDF values.
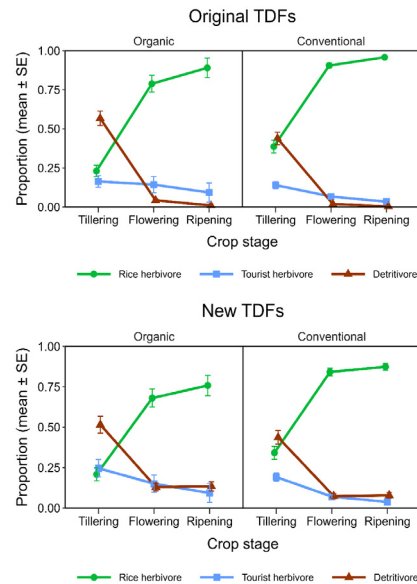
5) Given the following concerns that the pre-estabolished TDFs may not necessarily reflect our study system better than the TDFs derived from Caut et al. (2009), which are commonly used in stable isotope analysis, we decided to retain the original TDFs in the main text. However, we provide the results using pre-estabolished TDF in the Discussion (*Potential caveats of this study*) and Appendix C:

(a) Lycosid spiders, which are active-pursuit predators, may have higher metabolic rates than our studied spider taxa, which are primarily web-building sit-and-wait predators. Since metabolic rates can strongly influence isotope assimilation and enrichment processes (Martínez del Rio et al. 2009), the TDFs for Lycosid spiders may not accurately reflect those of our predators.

(b) Lycosid spiders in Oelbermann and Sechu (2002) consumed aphids, *Drosophila*, and collembolans, which differ from the primarily prey items in our study (e.g., *Nephotettix* and *Nilaparvata*; Table S1). Since prey species influence predators' stable isotope signatures, using the TDFs from Oelbermann and Sechu (2002) may introduce bias into our mixing models.

(c) TDFs can be influenced by experimental conditions, such as temperature, dietary nutritional content, and predator starvation status (McCutchan et al. 2003; Vanderklift and Ponsard 2003). Since the experimental conditions in Oelbermann and Sechu (2002) unlikely reflect our field conditions, we suggest that using the average TDFs from the synthesized study by Caut et al. (2009) may be a better approach, as adopted by many studies on generalist predators (e.g., Recalde et al. 2020, Nash et al. 2023, Otieno et al. 2023).

References:

Caut, S., Angulo, E., & Courchamp, F. (2009). Variation in discrimination factors (Δ^{15}N and Δ^{13}C): the effect of diet isotopic values and applications for diet reconstruction. *Journal of Applied Ecology*, *46*(2), 443-453.

Haraguchi, T. F., Uchida, M., Shibata, Y., & Tayasu, I. (2013). Contributions of detrital subsidies to aboveground spiders during secondary succession, revealed by radiocarbon and stable isotope signatures. Oecologia, 171, 935-944.

Martínez del Rio, C., Wolf, N., Carleton, S. A., & Gannes, L. Z. (2009). Isotopic ecology ten years after a call for more laboratory experiments. *Biological Reviews*, *84*(1), 91-111.

McCutchan Jr, J. H., Lewis Jr, W. M., Kendall, C., & McGrath, C. C. (2003). Variation in trophic shift for stable isotope ratios of carbon, nitrogen, and sulfur. *Oikos*, *102*(2), 378-390.

Mestre, L., Pinol, J., Barrientos, J. A., Espadaler, X., Brewitt, K., Werner, C., & Platner, C. (2013). Trophic structure of the spider community of a Mediterranean citrus grove: a stable isotope analysis. Basic and Applied Ecology, 14(5), 413-422.

Nash, L. N., Kratina, P., Recalde, F. C., Jones, J. I., Izzo, T., & Romero, G. Q. (2023). Tropical and temperate differences in the trophic structure and aquatic prey use of riparian predators. *Ecology Letters*, *26*(12), 2122-2134.

Oelbermann, K., & Scheu, S. (2002). Stable isotope enrichment (δ^{15}N and δ^{13}C) in a generalist predator (*Pardosa lugubris*, Araneae: Lycosidae): effects of prey quality. *Oecologia*, *130*, 337-344.

Otieno, N. E., Butler, M., & Pryke, J. S. (2023). Fallow fields and hedgerows mediate enhanced arthropod predation and reduced herbivory on small scale intercropped maize farms–δ^{13}C and δ^{15}N stable isotope evidence. *Agriculture, Ecosystems & Environment*, *349*, 108448.

Recalde, F. C., Breviglieri, C. P., & Romero, G. Q. (2020). Allochthonous aquatic subsidies alleviate predation pressure in terrestrial ecosystems. *Ecology*, *101*(8), e03074.

Sanders, D., Vogel, E., & Knop, E. (2015). Individual and species-specific traits explain niche size and functional role in spiders as generalist predators. Journal of Animal Ecology, 84(1), 134-142.

Vanderklift, M. A., & Ponsard, S. (2003). Sources of variation in consumer-diet δ^{15}N enrichment: a meta-analysis. *Oecologia*, *136*, 169-182.

11. L 217-233: Results should be left pending to new analyses including other potential preys and using more adequate TDFs.

[Reply] As suggested in the comment 9 and 10 above, we have refitted the stable isotope mixing models using an additional prey source and published TDFs. The new results were consistent with the original findings. Therefore, there is no need to change our main conclusions.

12. It would be desirable to add the ^{15}N vs. ^{13}C biplot including the convex hull defined by the sources and the position of predators used in Bayesian mixing model.

[Reply] We appreciate the reviewer's comment and have updated our Fig. S1 as suggested.
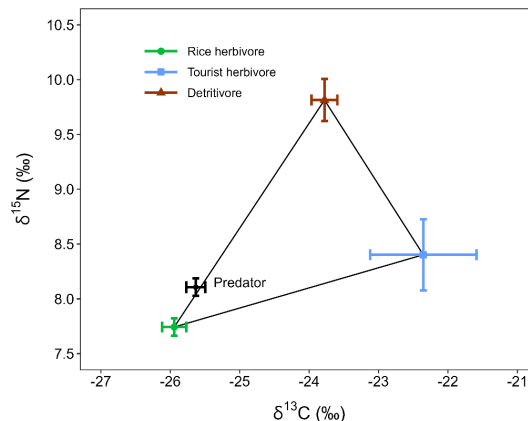
Figure S1. Stable isotope biplot showing the predator and three prey sources in this study. Points represent means and standard errors. The means for the three prey sources are adjusted for the trophic discrimination factors used in the sable isotope mixing models (Table S7).

13. L 235-245: This is an interesting result that could point to a promising role of GAPs as natural enemies in rice crops, but it would be interesting to see whether these changes in consumption rate over the season are related to a decrease in pest abundance in the crop and, if there is an effect, to test the effect of the cropping regime. That is, beyond a quantitative increase in pest consumption, do GAPs have a positive effect on reducing pest populations over time, and does the cropping regime affect the role of GAPs as natural enemies? I understand that this is not the aim of the manuscript but, if you have pest abundance data, a first approach to the role of GAPs in pest control could take your results a step further.

[Reply]

1) Thank Reviewer 3 for this thoughtful suggestion. Yes, we agree that it is important to examine whether high pest consumption by predators leads to effective pest control. However, our sampling design was structured to examine how herbivore composition affects predators' diet composition. To explore the potential feedback loop (e.g., how predators' diet composition in turn affects herbivore composition), a study would require greater sampling efforts to include diverse and less common species, as well as field manipulative experiments. This study limitation is addressed in our Discussion (*4.4. Potential caveats of this study*): "To unveil the connection between per capita pest consumption and overall pest dynamics, future work may require complementing stable isotope analysis with field experiments (e.g., manipulating predator density), along with assessments of crop damage and production, to better understand the overall effect of GAPs on pest control and crop performance."

2) That being said, we have now examined how predator abundance and rice herbivore abundance (number of individuals in field samples) are affected by year, farm type, crop stage, and percent forest cover (fixed effects), with farm ID nested within farm pair ID as a random effect. More details are in our response to Review 2's comment 5 above. The results show that predator abundance varied with years (2019 > 2017 and 2018) and crop stages (tillering > ripening > flowering) but not farm types and percent forest cover. Rice herbivore abundance also varied with years (2019 > 2017 and 2018) but not crop stages, farm

types, and percent forest cover. We have reported the aforementioned results in the Supplementary Information (Appendix A: Table S5).

Discussion

14. L 282: It is very honest that you comment that intraguild predation and pest suppression may be two potential caveats in your study. However, this is the first question that arises for the reader when reading the introduction, so I think you should include the importance of these two factors in terms of biological pest control at the outset to put the reader in context.

[Reply] We appreciate this comment and have modified the following sentences in the Introduction to raise awareness of these topics. However, we prefer not to address them in too detail in the Introduction, as our main focus is on diet composition.

"Quantifying diet composition (e.g., the proportions of different prey items in the predators' diet) will help address concerns that generalist predators may switch their diet from pests to alternative prey or interfere with each other (e.g., intraguild predation), thereby reducing their pest control effectiveness (Cuff et al. 2022; Hambäck et al. 2021; Michalko, Pekár & Entling 2019)."

"Moreover, fluctuations in abiotic factors and habitat conditions reportedly contribute to seasonal and yearly variations in prey density and species composition in agro-ecosystems (Dominik et al. 2018; Settle et al. 1996; Wardle et al. 1999), potentially influencing predator foraging behavior. Therefore, examining the consistency of pest consumption by generalist predators in the field over years is crucial to evaluate the stability of these predators as biocontrol agents in agriculture, although this information is lacking (knowledge gap 2)."

15. L 285: I understand that authors interpret that at the end of the season, of all the herbivore sources they have analysed, the most consumed by both predators are the pests. This is an interesting result that would denote a certain preference for pests. However, considering the need to include other prey non-herbivore in the Bayesian mixing model, and review the TDFs used in the analysis, this statement should be left pending new results.

[Reply] As suggested in the reviewer's comment 9 and 10, we have refitted the stable isotope mixing models by including predators as an additional prey source and using published TDFs. The results for these new analyses are generally consistent with the original findings and do not alter our main conclusions. Please see our responses to comment 9 and 10 above for more details.

16. L 337-342: I consider that this is an unexpected result and that it would be interesting to investigate why they consume more pests in conventional crops. Authors cannot assert that there is pest specialisation by generalist predators if they do not know the density of prey taxa in the crop. Perhaps they only feed on pests because that is all that is available. A simple way to do this would be to compare the densities of herbivores (the same ones that have been included in the stable isotope analysis) in the two crops and thus be able to resolve some of the reasons why this may be happening.

On the other hand, one of the main objectives of new agro-environmental schemes is to reduce the application of insecticides and promote biological pest control in crops. Therefore, although it is important to highlight the potential role of GAPs in conventional crops, the authors should indicate that, as a future direction, it would be crucial to know the role of GAPs in organic crops both in terms of efficiency in control of pests (since, as indicated in point 1, they can easily change prey in environments with high species diversity) and their relationship with other natural enemies.

[Reply]

1) Thank the reviewer for this thoughtful suggestion. We have now compared rice herbivore abundance between organic and conventional farms, and the results show that rice herbivore abundance did not differ significantly between the two farm types (Appendix A: Table S5; please see more details in our response to Reviewer 2's comment 5 above). Therefore, the higher pest consumption by predators in conventional farms may not be solely explained by pest availability.

2) We agree that GAPs' role in organic farms should also be addressed. We have now added the following sentences: "On the other hand, GAPs remain crucial for pest management in organic farms, particularly in the absence of pesticides. We encourage future studies to investigate their biocontrol effectiveness and interactions with other natural enemies in organic systems."

17. L 352-354: Just a comment that I assume the authors will have taken into account and which could be commented on in the discussion section. The surrounding habitat may be affecting in terms of recruitment of individuals. That is, it has been described that natural or semi-natural vegetation surrounding the main crop may act as a refuge for natural enemies when pests are scarce by favouring the migration of natural enemies into the crop when herbivore population densities increase throughout the season. Thus, although the results showed no effect on predator diet composition, this effect could be essential in terms of pest control efficiency.

[Reply] Thank the reviewer for pointing this out. Accordingly, we have added this sentence in our Discussion: "Note that surrounding vegetation (e.g., cropping system mosaic) may still influence pest control efficacy by affecting the population dynamics and persistence of predators and prey (Vasseur et al. 2013)."

Appendix A

18. Table S3: It would be interesting to separate the abundance data by cropping regime and by the classification of guilds done in the manuscript: rice herbivores, tourist herbivores and detritivore.

[Reply] As suggested, we have separated the abundance data by crop stages (Appendix A: Table S3) and by prey guilds (Appendix A: Table S6).

Table S3. The relative abundance of the major families/genera in rice herbivore guild at the flowering and ripening stages in organic and conventional farms in the three study years. Samples were pooled across replicate farms.

(a) Flowering stage

Family/Genus	Year 2017		Year 2018		Year 2019	
	Organic	Conventional	Organic	Conventional	Organic	Conventional
Cicadellidae/*Nephotettix*	6.70%	8.30%	28.10%	17.70%	63.90%	73.70%
Delphacidae/*Nilaparvata*	84.80%	90.40%	65.50%	77.30%	29.90%	22.10%
Lygaeidae/*Pachybrachius*	NA	NA	1.70%	NA	2.10%	0.80%
Pentatomidae/*Scotinophara*	1%	0.60%	1.70%	4%	1.50%	0.30%
Others	7.60%	0.60%	3%	1.10%	2.50%	3.10%
Total	100%	100%	100%	100%	100%	100%

(b) Ripening stage

Family/Genus	Year 2017		Year 2018		Year 2019	
	Organic	Conventional	Organic	Conventional	Organic	Conventional
Cicadellidae/*Nephotettix*	62.10%	71.70%	72%	78.20%	57%	92.70%
Delphacidae/*Nilaparvata*	34.50%	27.20%	15.30%	11.20%	12.40%	4%
Lygaeidae/*Pachybrachius*	NA	NA	NA	0.50%	15.10%	0.30%
Pentatomidae/*Scotinophara*	3.40%	1.10%	11.40%	9.20%	10.20%	2.50%
Others	NA	NA	1.30%	1%	5.20%	0.60%
Total	100%	100%	100%	100%	100%	100%

Table S6. Number of individuals (mean ± SE) from three prey guilds collected using the sweep-net method during the flowering and ripening stages in organic and conventional farms over three study years. Values represent averages across replicate farms.

(a) Flowering stage

Prey guild	Year 2017		Year 2018		Year 2019	
	Organic	Conventional	Organic	Conventional	Organic	Conventional
Rice herbivore	32.7 ± 17.7	54.3 ± 17.2	32.6 ± 7.5	39.1 ± 7.4	100.7 ± 46.4	143.3 ± 53.6
Tourist herbivore	2.5 ± 0.5	3	7.7 ± 6.2	3	1	1
Detritivore	53.7 ± 20	101.3 ± 47.7	6.3 ± 2.7	5.8 ± 3.1	14.9 ± 3.1	12.4 ± 2.9

(b) Ripening stage

Prey guild	Year 2017		Year 2018		Year 2019	
	Organic	Conventional	Organic	Conventional	Organic	Conventional
Rice herbivore	29.0	30.7 ± 20.1	33.3 ± 10.0	29.3 ± 8.8	94.6 ± 33.8	289.0 ± 172.7
Tourist herbivore	NA	NA	3	NA	2.5 ± 1.5	1.7 ± 0.7
Detritivore	6.0 ± 2.0	27.0 ± 22.5	3.5 ± 1.0	2.4 ± 0.9	13.4 ± 4.8	17.8 ± 9.4

19. L 45: "Three years of study"

[Reply]   We have revised as suggested: "**Figure S3.** Daily mean temperature and precipitation of the study sites during the rice growth season (April to July) of the three years of study."